# Memorandum

Cardno ENTRIX
Shaping the Future

Cardno ENTRIX

5252 Westchester Street
Suite 250
Houston, TX 77005
USA

Phone 713 666 6223
Toll-free 800 368 7511
Fax 713 666 5227
www.cardno.com

www.cardnoentrix.com

**Date** November 4, 2011

**RE:** **Modifications to Risk Evaluations in Sensitivity Analysis Scenario 10b**
**Star Lake Canal Superfund Site**
**Jefferson County, Texas**

---

## 1.0 Executive Summary

Remediation Scenarios have been evaluated to determine upper trophic level risk following various combinations of soil and sediment remediation at the Star Lake Canal Superfund Site (Site). Scenario 10b evaluated the resulting risk to upper trophic level receptors after a remediation is conducted on the Jefferson Canal Spoil Pile and sediment sample areas with a medium-high or high risk to benthic invertebrates. For this scenario evaluation, an unrealistic assumption was made that soil-exposed dietary items would have a zero concentration following the proposed remediation. The remaining risk to upper trophic level receptors was evaluated for overly conservative measures that could be driving the risk calculation. Modifications to the risk evaluations were made based on these conservative measures and the resulting hazard quotients are presented. It is recommended that additional evaluations of Scenarios 11b, 12b, and 13b using these modifications be conducted to evaluate the remedial scenario effectiveness. A new scenario is proposed which incorporates these modifications and investigates the risk following a remediation of the Jefferson Canal Spoil Pile and sediment samples areas with medium-high and high risk to benthic invertebrates except those sample areas found within Molasses Bayou. It is also recommended that a Net Environmental Benefits Analysis (NEBA) be initiated to further examine remedial scenario effectiveness.

## 2.0 Introduction

A sensitivity analysis was conducted as part of the Feasibility Study scoping process to evaluate the contributions of the various soil and sediment sample areas to overall Site risk. The exercise will facilitate the development of remedial action alternatives that will focus on remediation that could be implemented at specific media sample locations resulting in an overall reduction of constituent of potential ecological concern (COPEC) exposure to an acceptable risk level.

Various remediation scenarios have been developed to determine the best combination of remedial actions at sediment and soil locations that most efficiently achieves the goal of managing future ecological risk at the Site. As part of the sensitivity analysis, reasonable maximum exposures (RMEs) were recalculated based on remediation at the chosen locations and used in exposure models along with the use of bioaccumulation factors (BAFs) to predict the concentration in the prey item following remediation. See **Table 1** for a description of each remediation scenario evaluated in the sensitivity analysis.

Scenario 10b is focused on remediating sediment sample areas that likely pose unacceptable risk to benthic invertebrates and also remediating all areas of the Jefferson Canal Spoil Pile. Sediment sample areas with an ERM/PEL-Q category score of 3 (Medium High Priority) or 4 (High Priority) are assumed to be remediated to concentrations at or below half of the first effects benchmarks for each respective COPEC. Soil is assumed to be remediated to the Texas median background concentration or in cases where there is no background concentration available, to $1^{st}$ effects benchmarks for terrestrial invertebrates. Dietary items that were assumed to accumulate COPEC concentrations as a result of contaminated sediment exposure were calculated by multiplying a BAF by the sediment RME. Dietary items that were assumed to accumulate COPEC concentrations through soil exposure were set to a zero concentration in the exposure models as an assumption that these items pose no risk after all of the soil is remediated to background levels. Scenario 10b evaluation assesses the degree of risk calculated by the models as a result of dietary items liked to soil exposure. It is an unrealistic assumption to set these dietary items at a zero concentration based on remediation of the Jefferson Canal Spoil Pile to background levels. As there would still be COPEC concentrations at background levels, it is a more realistic assumption that soil-linked dietary items would have concentrations predicted by the Site-specific BAF. Realistic hazard quotient results are presented in Scenario 11b, in which dietary item concentrations are calculated with Site-specific BAFs linked to background soil concentrations.

Results from Scenario 10b indicate acceptable risk levels for most of the COPECs that were evaluated in the sensitivity analysis. Scenarios 11b, 12b, and 13b also indicate acceptable risk levels for these COPECs given the assumptions that are made in Scenario 10b. Acceptable risk levels were established as any COPEC in which the $HQ_{[GMATC]} < 1$ for all receptors and the $HQ_{[NOAEL]} < 1$ for threatened and endangered (T&E) receptors. Each COPEC found to have unacceptable risk levels with Scenario 10b was evaluated for conservative measures that could be contributing to an HQ>1 (source of the highest dose, prey item concentrations calculated with BAFs that are not Site-specific, TRV uncertainty) as well as issues that can help better define the risk to upper trophic level receptors such as bioavailability due to soil chemistry.

Modifications to the risk evaluations are presented for each COPEC to address the conservative assumptions that may be overestimating the remaining risk following a remediation based on Scenario 10b.

## 3.0 COPECS Not Eliminated in Scenario 10b

### 3.1 Pentachlorophenol

- Raccoon $HQ_{[GMATC]} = 1.57$
- Painted turtle $HQ_{[NOAEL]} = 2.10$

A large majority of the pentachlorophenol total daily dose (TDD) in raccoons was from ingestion of prey items, specifically mollusks (97.44% of TDD). The predicted pentachlorophenol concentration in mollusks was modeled with a literature-derived sediment-to-mollusk BAF of 3308.8. A Site-specific BAF for mollusks was not included in the exposure models as this prey item was not collected at the Site. This mollusk BAF (3308.8) was based on a recommended bioconcentration factor (BCF) value from USEPA (1999) multiplied by the food chain multiplier (FCM). The recommended BCF was calculated using a regression equation (log BCF = 0.819 x log $K_{ow}$ - 1.146) due to the lack of available empirical data (USEPA 1999). According to USEPA (1995), a measured baseline BAF for an organic or inorganic chemical derived from a field study of acceptable quality is the most preferred method for deriving baseline BAFs. Conversely, deriving a baseline BAF from a predicted baseline BAF for an organic chemical derived from a $K_{ow}$ of acceptable quality and a FCM is the least preferred method. There is concern that the TDD of the raccoon is overly conservative due to the mollusk concentration being calculated with a non-empirically derived BAF.

### 3.1.1 Modifications to Risk Evaluation

Using a non-empirically derived BAF to calculate concentrations that contribute the largest exposure source to the raccoon can be considered an overly conservative exposure assumption. This assumption supports the use of a LOAEL-based HQ for the raccoon (TCEQ 2005), which has a value less than one ($HQ_{[LOAEL]}$ = 0.70).

The painted turtle was selected as a surrogate species for the state-threatened alligator snapping turtle due to the exposure information that is available for the surrogate species. However, there is considerable difference in the diet of these two species, with a majority carnivorous diet occurring in the alligator snapping turtle and a majority herbivorous diet occurring in the painted turtle. As dietary dose in the alligator snapping turtle is most likely to be attributable to fish, the dietary proportions were modified in the painted turtle exposure model to 100% fish. This change in dietary exposure source resulted in an $HQ_{[NOAEL]}$ = 0.06.

The raccoon $HQ_{[LOAEL]}$ = 0.70 and painted turtle $HQ_{[NOAEL]}$ = 0.06 indicate acceptable risk levels for these species exposed to Site-wide concentrations of pentachlorophenol following remediation according to Scenario 10b.

## 3.2 Aluminum

- American robin $HQ_{[GMATC}$ = 3.04
- Short-tailed shrew $HQ_{[GMATC]}$ = 1.11
- Belted kingfisher $HQ_{[GMATC]}$ = 32.78
- Marsh wren $HQ_{[GMATC]}$ = 11.39
- Spotted sandpiper $HQ_{[GMATC]}$ = 29.15
- Wood stork $HQ_{[NOAEL]}$ = 1.51
- Bullfrog $HQ_{[GMATC]}$ = 1.54

- Painted turtle $HQ_{[NOAEL]}$ = 1.28

Dietary items were not the risk driver for the American robin or the short-tailed shrew as these receptors consume terrestrial dietary items that were assumed to pose no risk to the receptor when all soil is remediated. Using these assumptions in Scenario 10b, the majority of the TDD (98.75% in the American robin and 99.7% in the short-tailed shrew) was from ingestion of the soil at background levels. While ingesting these concentrations did result in a HQ>1, it can be assumed that aluminum is not bioavailable to the receptors as most pH readings in the soil samples were above 7.0. This is based on the Eco-SSL for Aluminum (USEPA 2003) that states the following:

> *Because the measurement of total aluminum in soils is not considered suitable or reliable for the prediction of potential toxicity and bioaccumulation, an alternative procedure is recommended for screening aluminum in soils. The procedure is intended as a practical approach for determining if aluminum in site soils could pose a potential risk to ecological receptors. This alternative procedure replaces the derivation of numeric Eco-SSL values for aluminum. Potential ecological risks associated with aluminum are identified based on the measured soil pH. Aluminum is identified as a COPC only at sites where the soil pH is less than 5.5 (EPA 2003).*

Based on Scenario 10b, the belted kingfisher, wood stork, and bullfrog were receiving the highest dosage of aluminum from fish ingestion (93.8% of TDD, 98.39% of TDD, and 78.30, respectively). The marsh wren and spotted sandpiper were receiving the largest percentage of their TDD from sediment ingestion (98.78% and 74.88%, respectively). The highest dosage of aluminum in the painted turtle was due to vegetation (52.63% of TDD) and fish (33.59% of TDD).

Hazard quotients for the belted kingfisher, marsh wren, and spotted sandpiper were calculated with a TRV based on a single oral dose $LC_{50}$ for red-winged blackbird of >111 mg/kg-bw exposed to aluminum (Schafer et al. 1983). A single oral dose $LC_{50}$ for house sparrow of >250 mg/kg-bw exposed to aluminum was also found (Schafer et al. 1983). The value of 111 mg/kg-bw for red-winged blackbird was divided by a UF = 100 to estimate a chronic NOAEL, resulting in a TRV of 1.11 mg/kg-bw/day. As the highest dose tested in both of the studies did not produce a true LC50, there is considerable conservatism in using this concentration for extrapolation to a chronic NOAEL.

No data were found regarding waterfowl, reptile, or amphibian exposure to aluminum, therefore the wood stork, bullfrog, and painted turtle TRV is based on the chicken TRV. This value was divided by 5 to account for interspecies variability for waterfowl. The chicken TRV was divided by 10 to account for interclass extrapolation for reptiles and amphibians. Using an uncertainty factor due to extrapolation between species and classes can result in an overly conservative TRV.

### 3.2.1 Modifications to Risk Evaluation

Soil pH levels at the Site indicate aluminum is not bioavailable to the receptors (USEPA 2003), therefore this COPEC is assumed to pose acceptable risk levels to the upper trophic level receptors.

### 3.3 Chromium VI

- Belted kingfisher $HQ_{[GMATC]} = 4.23$
- Spotted sandpiper $HQ_{[GMATC]} = 1.01$
- Bullfrog $HQ_{[GMATC]} = 2.69$
- Painted turtle $HQ_{[NOAEL]} = 1.04$

All receptors found to be at risk from hexavalent chromium exposure in Scenario 10b were receiving the largest source of risk from dietary items. Risk drivers to the belted kingfisher were consumption of fish (96.12% of TDD) and crustaceans (3.81% of TDD). Risk drivers to the spotted sandpiper were also consumption of fish (45.59% of TDD) and crustaceans (45.59% of TDD). The bullfrog was getting the largest daily dose from fish (78.64% of TDD) and insects (11.01% of TDD). Risk drivers to the painted turtle were consumption of fish (9.35% of TDD), insects (64.48% of TDD), vegetation (16.03% of TDD) and crustaceans (9.35% of TDD).

Site-specific BAFs were not able to be calculated for fish, crustaceans, or mollusk dietary items due to lack of tissue data from the Site. The dietary item RMEs were calculated with a literature-derived BAF. By not using a Site-specific BAF for these dietary items, it is likely the RMEs are not accurately calculating bioaccumulation of chromium VI in dietary items at the Site. This could lead to an overestimation of the predicted concentration in fish, crustaceans, and mollusks that would be found given the various remediation scenarios at the Site. It should also be noted that upper trophic level receptors consuming aquatic species may be at less risk than assumed from the calculated HQ because there is no significant biomagnification of chromium in aquatic food webs (ATSDR, 1993). The toxic effects of chromium are primarily found at the lower trophic levels. Chromium may bioaccumulate in algae, other aquatic vegetation, and invertebrates, but it does not biomagnify. Further, chromium+6 is readily converted to chromium+3 in animals, which appears to protect higher organisms from the effects of low level exposures (Eisler 1986).

In addition to the use of literature-derived BAFs, the dietary item concentrations could also be inaccurate due to the sediment RME used in the calculation. The sediment RME was not based on all sediment samples at the Site because 19 of the sediment samples (17% of the total) collected at the Site were rejected for analytical testing. Of the samples that were not rejected, only 12% had detectable concentrations. Therefore, there should be concern that the sediment RME is based not only on insufficient data but also on a large majority of detection limits.

TRV uncertainty and conservatism could be a factor in the HQ calculations. As no data were found regarding songbirds and passerines, the chicken TRV was used to extrapolate the TRV for the belted kingfisher and the spotted sandpiper by dividing by 5 to account for inter-taxon variability. The chicken TRV was also used to extrapolate the TRV for the bullfrog and painted turtle due to lack of exposure data. The chicken TRV was divided by an uncertainty factor of 10 to account for interclass variation. Using an uncertainty factor due to extrapolation between species and classes can result in an overly conservative TRV.

## 3.4 Modifications to Risk Evaluations

As dietary dose in the alligator snapping turtle is most likely to be attributable to fish, the dietary proportions were modified in the painted turtle exposure model to 100% fish. This change in dietary exposure source resulted in acceptable risk levels ($HQ_{[NOAEL]}$ = 0.62).

Sediment RMEs were calculated using half detection limits for the samples with non-detectable concentrations due to the concern of high detection limits driving the sediment RME. Using this revised sediment RME, risk calculations were as follows: belted kingfisher $HQ_{[GMATC]}$ = 0.85, spotted sandpiper $HQ_{[GMATC]}$ = 0.98, and bullfrog $HQ_{[GMATC]}$ = 0.64.

The modified exposure factors (diet in the painted turtle model and half detection limits for sediment non-detects in the spotted sandpiper, belted kingfisher, and bullfrog models) resulted in risk calculations that indicate acceptable risk levels at the Site for these receptors following remediation according to Scenario 10b. A lack of significant biomagnification in the upper trophic level receptors consuming aquatic species indicates acceptable risk levels for these receptors as well.

## 3.5 Copper

- Belted kingfisher $HQ_{[GMATC]}$ = 1.39
- Spotted sandpiper $HQ_{[GMATC]}$ = 1.39

Risk drivers in the belted kingfisher were mainly from food ingestion (37.98% of TDD from fish, 4.98% of TDD from amphibians, and 56.99% of TDD from crustaceans). Risk drivers in the spotted sandpiper were due to ingestion of fish (15.01% of TDD), crustaceans (72.90% of TDD), and sediment (12.02% of TDD).

Of the 113 surface sediment samples evaluated, 12 had total SEM/AVS concentrations greater than 1.0. The freshwater samples included one location in Jefferson Canal (JC-13). The saltwater samples included one location in the Gulf States Utility Canal (GSUC-10), six locations in Molasses Bayou (MB-2, MB-12, MB-13, MB-23, MB-59, MB-63), three locations in Former Star Lake (SL-6, SL-7, SL-9), and one location in Star Lake Canal (SLC-6). Seven of these sediment samples have an ERM/PEL-Q Score >2, therefore will be remediated in Scenario 10b. The remaining 101 samples had total SEM values less than their AVS concentrations indicating that these metals in the sediment pore water are precipitated as a metal sulfide and are not likely to be bioavailable. It can be assumed that metal concentrations will decrease in the remediated sample areas, leaving only five sediment samples at the Site with bioavailable copper concentrations.

### 3.5.1 Modifications to Risk Evaluations

Risk calculations that do not take into account the presence of metal sulfides at the Site likely overestimate risk to the receptors as copper concentrations are not largely bioavailable. This conservatism in the exposure models warrants the use of a LOAEL-based HQ for risk determination. The $HQ_{[LOAEL]}$ for the belted kingfisher and spotted sandpiper ($HQ_{[LOAEL]}$ = 0.622 for both species) indicates acceptable risk levels for these species exposed to Site-wide concentrations of copper following remediation according to Scenario 10b.

## 3.6 Manganese

- Muskrat $HQ_{[GMATC]} = 2.97$
- Belted kingfisher $HQ_{[GMATC]} = 1.49$
- Painted turtle $HQ_{[NOAEL]} = 8.02$

Risk to the muskrat was largely driven by vegetation in the diet (99.98% of TDD). Risk from manganese exposure in the belted kingfisher was also due to dietary items, but drivers were crustaceans (90.25%) and fish (8.43% of TDD). The painted turtle was determined to be at risk due to ingestion of vegetation (43.12% of TDD) and crustaceans (50.49% of TDD).

The belted kingfisher TRV is based on a 6-week (approximate test duration) value of 7.3 mg/kg-bw/day for guinea fowl exposed to manganese sulfate (Offiong and Abed 1980). This study was designed to assess the nutritional deficiencies of manganese and the maximum dose examined significantly improved the fertility, hatchability, and embryos of guinea fowl compared to controls. Therefore, the maximum dose examined (70 mg/kg feed; 7.3 mg/kg-bw/day) represents a required dose for successful reproduction and is likely considerably lower than a true NOAEL. As such, this value should be considered extremely conservative.

No data were found on reptile or amphibian exposure to manganese, therefore the avian TRV was used for extrapolation by dividing by an uncertainty factor of 10 to account for interclass variation, resulting in a TRV of 0.73 mg/kg-bw/day. As the avian TRV is likely an overly conservative value, adding an additional uncertainty factor for extrapolation to reptiles and amphibians is also very likely to be an overly conservative measure of risk.

### 3.6.1 Modifications to Risk Evaluations

As dietary dose in the alligator snapping turtle is likely to come mostly from fish, the dietary proportions were modified in the painted turtle exposure model to 100% fish. This change in dietary exposure source resulted in acceptable risk levels ($HQ_{[NOAEL]} = 0.34$).

TRVs previously used in the exposure models for the muskrat and belted kingfisher were replaced by TRVs for mammalian and avian species, respectively, found in the Eco-SSL for Manganese (EPA 2007). The avian TRV is based on the geometric mean of the reported NOAELs for growth and reproduction in 21 studies approved according to Eco-SSL guidance. The geometric mean of these NOAEL values for reproduction and growth was calculated at 179 mg manganese/kg bw/day. Fifty-eight studies were approved according to Eco-SSL guidance for use in the derivation of a mammalian TRV. The geometric mean of the 58 reported NOAELs for reproduction and growth was calculated at 51.5 mg manganese/ kg bw/day. Using these less conservative TRVs, manganese exposure to the muskrat and belted kingfisher was determined to be at acceptable risk levels (muskrat $HQ_{[GMACT]} = 0.51$, belted kingfisher $HQ_{[GMACT]} = 0.061$) following remediation according to Scenario 10b.

## 4.0 Conclusions

Remaining risk to upper trophic level receptors can potentially be addressed by developing a protective concentration level (PCL) to be used as a preliminary remediation goal (PRG). As a PCL requires the HQ = 1, there needs to be consideration as to which HQ is the most appropriate value ($HQ_{NOAEL}$, $HQ_{GMACT}$, or $HQ_{LOAEL}$). While TCEQ (2006) has developed some guidelines to follow in determining the most appropriate PCL, the TRRP rule is intentionally silent on how to select a comparative ecological PCL that is bounded by the NOAEL and LOAEL to allow one the flexibility of making this determination. For example, situations where only conservative exposure assumptions have been used will support the use of a LOAEL-based PCL (TCEQ 2005). Additionally, if a combination of less conservative and conservative assumptions have been used, it may be appropriate to use a PCL value that is bounded by the upper and lower effect levels but is biased toward the LOAEL bound (TCEQ 2006). An exception to using the average of the NOAEL and LOAEL-based PCLs can also be made in some cases where there is TRV uncertainty. Development of a PCL for consideration as a PRG should take into account the uncertainty of the conservative measures used in the exposure models (TCEQ 2005).

Risk calculations for COPECs showing unacceptable risk as a result of conservative measures were modified to provide a more realistic prediction of risk to upper trophic level receptors following remediation. These modifications included adjustments to the dietary components of the alligator snapping turtle surrogate species (painted turtle), using the $HQ_{[LOAEL]}$ to measure risk, using soil pH levels and AVS/SEM ratios to determine bioavailability, setting non-detect sample concentrations at half detection limits, and using a more appropriate manganese TRV for avian and mammals. With these modifications, all COPECs were found to pose acceptable risk levels following remediation according to Scenario 10b. As it is an unrealistic assumption to set dietary items to a zero concentration given exposure to soil background levels, the HQs results from Scenario 11b are more indicative of the remaining risk following this remediation. We recommend additional evaluations of Scenarios 11b, 12b, and 13b using these modifications to evaluate the remedial scenario effectiveness. A new scenario is proposed which incorporates these modifications and investigates the risk following a remediation of the Jefferson Canal Spoil Pile and sediment samples areas with medium-high and high risk to benthic invertebrates except those sample areas found within Molasses Bayou. It is recommended that a NEBA be initiated to further examine remedial scenario effectiveness.

## 5.0 References

Agency for Toxic Substances and Disease Registry (ATSDR). 1993. Toxicological Profile for Chromium. U.S. Dept. Health & Human Services, TP-92/08.

Eisler, R. 1986. Chromium Hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish Wildl. Serv. Biol. Rep. 85(1.6).

Offiong, S.A. and S.M. Abed. 1980. Fertility, hatchability and malformations in guinea fowl embryos as affected by dietary manganese. Brit. Poult. Sci. 21:371-375.

Schafer, E.W., Jr., W.A. Bowles and J. Hurlbut. 1983. The acute oral toxicity, repellency, and hazard potential of 998 chemicals to one or more species of wild and domestic birds. Arch. Environ. Contam. Toxicol. 12:355-382.

Texas Commission of Environmental Quality (TCEQ). 2005. Position Paper on Common Issues Encountered During the Review of Ecological Risk Assessments. Remediation Division. September.

Texas Commission on Environmental Quality (TCEQ). 2006. Update to Guidance for Conducting Ecological Risk Assessments at Remediation Sites in Texas RG-263 (Revised). Remediation Division. January.

U.S. Environmental Protection Agency (USEPA). 1995. Great Lakes Water Quality Initiative Technical Support Document for the Procedure to Determine Bioaccumulation Factors. EPA-820-B-95-005. Office of Water. March.

U.S. Environmental Protection Agency (USEPA). 1999. Solid Waste and Emergency Response (5305W), Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Volume 2, Appendix A: chemical-specific data, Appendix C: Media-to-Receptor Bioconcentration Factors (BCFs); and Appendix d: Bioconcentration Factors (BCFs) for Wildlife Measurement Receptors, USEPA August 1999.

U.S. Environmental Protection Agency (USEPA). 2003. Ecological Soil Screening Level for Aluminum. Interim Final. OSWER Directive 9285.7-60. November 2003.

U.S. Environmental Protection Agency (USEPA). 2007. Ecological Soil Screening Level for Manganese. Interim Final. OSWER Directive 9285.7-71. April 2007.

# TABLE 1
# REMEDIATION SCENARIO DESCRIPTIONS
# STAR LAKE CANAL SUPERFUND SITE
# JEFFERSON COUNTY, TEXAS

| | |
|---|---|
| **1** | **No remediation** |
| | |
| **2** | **Remediate all of Jefferson Canal Spoil Pile soil samples** |
| | Using background levels in soil; only changing sample concentrations that are larger than these values |
| | |
| **3** | **Remediate the top 5 hottest sediment samples and the top 5 hottest soil samples** |
| a | Using 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| b | Using ½ 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| | |
| **4** | **Remediate top 10 hottest sediment samples in Jefferson Canal and Former Star Lake and the 6 Jefferson Canal Spoil Pile hot spots along the canal** |
| a | Using 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| b | Using ½ 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| c | Same as 2a with the addition of MB-21, MB-28, and MB-63 |
| d | Same as 2b with the addition of MB-21, MB-28, and MB-63 |
| | |
| **5** | **Remediate top 10 hottest sediment found in Jefferson Canal and Former Star Lake and all of the Jefferson Canal Spoil Pile** |
| a | Using 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| b | Using ½ 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| | |
| **6** | **Remediate all of the "To be addressed in the FS" sediment samples and none of the Jefferson Canal Spoil Pile** |
| a | Using 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| b | Using ½ 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| | |
| **7** | **Remediate all of the "To be addressed in the FS" sediment samples and all of the Jefferson Canal Spoil Pile** |
| a | Using 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| b | Using ½ 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| | |
| **8** | **Remediate all sediment and soil samples at the Site** |
| a | Using 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| b | Using ½ 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |

c Using detection limits in sediment, detection limits in dietary items, and background levels in soils

**9 Remediate all sediment samples with a 3 (Med-high) or 4 (High) ERM-Q/PEL-Q Priority category and none of the Jefferson Canal Spoil Pile**
a Using 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values
b Using ½ 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values
c Using detection limits in sediment and background levels in soils; only changing sample concentrations that are larger than these values

**10 Remediate all sediment samples with a 3 (Med-high) or 4 (High) ERM-Q/PEL-Q Priority category and all of the Jefferson Canal Spoil Pile**
a Using 1st effects benchmarks in sediment, background levels in soils, and all dietary items linked to soil set to zero
b Using ½ 1st effects benchmarks in sediment, background levels in soils, and all dietary items linked to soil set to zero
c Using detection limits sediment, background levels in soils, and all dietary items linked to soil set to zero

**11 Remediate all sediment samples with a 3 (Med-high) or 4 (High) ERM-Q/PEL-Q Priority category and all of the Jefferson Canal Spoil Pile**
a Using 1st effects benchmarks in sediment, background levels in soils, and BAFs for all dietary items
b Using ½ 1st effects benchmarks in sediment, background levels in soils, and BAFs for all dietary items
c Using detection limits sediment, background levels in soils, and BAFs for all dietary items

***12 Remediate all sediment samples with a 3 (Med-high) or 4 (High) ERM-Q/PEL-Q Priority category with the exception of MB-26, MB-51, MB-58, MB-59, MB-62, MB-63, MB-56 and also remediate all of the Jefferson Canal Spoil Pile***
*a Using 1st effects benchmarks in sediment, background levels in soils, and BAFs for all dietary items*
*b Using ½ 1st effects benchmarks in sediment, background levels in soils, and BAFs for all dietary items*
*c Using detection limits sediment, background levels in soils, and BAFs for all dietary items*

***13 Remediate all sediment samples with a 3 (Med-high) or 4 (High) ERM-Q/PEL-Q Priority category with the exception of MB-26, MB-51, MB-58, MB-59 and also remediate all of the Jefferson Canal Spoil Pile***
*a Using 1st effects benchmarks in sediment, background levels in soils, and BAFs for all dietary items*
*b Using ½ 1st effects benchmarks in sediment, background levels in soils, and BAFs for all dietary items*
*c Using detection limits sediment, background levels in soils, and BAFs for all dietary items*

Note:
Italics denotes a new scenario that has not been presented.

# TABLE 1
# REMEDIATION SCENARIO DESCRIPTIONS
# STAR LAKE CANAL SUPERFUND SITE
# JEFFERSON COUNTY, TEXAS

**1 No remediation**

**2 Remediate all of Jefferson Canal Spoil Pile soil samples**

Using background levels in soil; only changing sample concentrations that are larger than these values

**3 Remediate the top 5 hottest sediment samples and the top 5 hottest soil samples**

a Using 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values

b Using ½ 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values

*c Using detection limits in sediment and background levels in soils*

**4 Remediate top 10 hottest sediment samples in Jefferson Canal and Former Star Lake and the 6 Jefferson Canal Spoil Pile hot spots along the canal**

a Using 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values

b Using ½ 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values

c Same as 2a with the addition of MB-21, MB-28, and MB-63

d Same as 2b with the addition of MB-21, MB-28, and MB-63

*e Using detection limits in sediment and background levels in soils*

*f Same as 4e with the addition of MB-21, MB-28, and MB-63*

**5 Remediate top 10 hottest sediment found in Jefferson Canal and Former Star Lake and all of the Jefferson Canal Spoil Pile**

a Using 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values

b Using ½ 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values

*c Using detection limits in sediment and background levels in soils*

**6 Remediate all of the "To be addressed in the FS" sediment samples and none of the Jefferson Canal Spoil Pile**

a Using 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values

b Using ½ 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values

*c Using detection limits in sediment and background levels in soils*

**7 Remediate all of the "To be addressed in the FS" sediment samples and all of the Jefferson Canal Spoil Pile**

a Using 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values

# TABLE 1
# REMEDIATION SCENARIO DESCRIPTIONS
# STAR LAKE CANAL SUPERFUND SITE
# JEFFERSON COUNTY, TEXAS

| | |
|---|---|
| b | Using ½ 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| *c* | *Using detection limits in sediment and background levels in soils* |
| | |
| **8** | **Remediate all sediment and soil samples at the Site** |
| a | Using 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| b | Using ½ 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| *c* | **Using detection limits in sediment, detection limits in dietary items, and background levels in soils* |
| | |
| ***9*** | ***Remediate all sediment samples with a 3 (Med-high) or 4 (High) ERM-Q/PEL-Q Priority category and none of the Jefferson Canal Spoil Pile*** |
| *a* | *Using ½ 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values* |
| *b* | *Using detection limits in sediment and background levels in soils* |
| | |
| ***10*** | ***Remediate all sediment samples with a 3 (Med-high) or 4 (High) ERM-Q/PEL-Q Priority category and all of the Jefferson Canal Spoil Pile*** |
| *a* | *Using ½ 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values* |
| *b* | *Using detection limits in sediment and background levels in soils* |

Note:

1st effects benchmarks for sediment are concentrations protective of the benthic community.

Italics denotes a new scenario that was not presented at the August 31, 2011 meeting with EPA.

*Scenario 8c results are included in the following tables; no other new scenarios have been run at this time.



017085

**TABLE 1**
**REMEDIATION SCENARIO DESCRIPTIONS**
**STAR LAKE CANAL SUPERFUND SITE**
**JEFFERSON COUNTY, TEXAS**

| | |
|---|---|
| **1** | **No remediation** |
| | |
| **2** | **Remediate all of Jefferson Canal Spoil Pile soil samples** |
| | Using background levels in soil; only changing sample concentrations that are larger than these values |
| | |
| **3** | **Remediate the top 5 hottest sediment samples and the top 5 hottest soil samples** |
| a | Using 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| b | Using ½ 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| | |
| **4** | **Remediate top 10 hottest sediment samples in Jefferson Canal and Former Star Lake and the 6 Jefferson Canal Spoil Pile hot spots along the canal** |
| a | Using 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| b | Using ½ 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| c | Same as 2a with the addition of MB-21, MB-28, and MB-63 |
| d | Same as 2b with the addition of MB-21, MB-28, and MB-63 |
| | |
| **5** | **Remediate top 10 hottest sediment found in Jefferson Canal and Former Star Lake and all of the Jefferson Canal Spoil Pile** |
| a | Using 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| b | Using ½ 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| | |
| **6** | **Remediate all of the "To be addressed in the FS" sediment samples and none of the Jefferson Canal Spoil Pile** |
| a | Using 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| b | Using ½ 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| | |
| **7** | **Remediate all of the "To be addressed in the FS" sediment samples and all of the Jefferson Canal Spoil Pile** |
| a | Using 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| b | Using ½ 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |
| | |
| **8** | **Remediate all sediment and soil samples at the Site** |
| a | Using 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values |

# TABLE 1
# REMEDIATION SCENARIO DESCRIPTIONS
# STAR LAKE CANAL SUPERFUND SITE
# JEFFERSON COUNTY, TEXAS

b Using ½ 1st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values

c Using detection limits in sediment, detection limits in dietary items, and background levels in soils

***9 Remediate all sediment samples with a 3 (Med-high) or 4 (High) ERM-Q/PEL-Q Priority category and none of the Jefferson Canal Spoil Pile***

*a Using 1 st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values*

*b Using ½ 1 st effects benchmarks in sediment and background levels in soils; only changing sample concentrations that are larger than these values*

*c Using detection limits in sediment and background levels in soils; only changing sample concentrations that are larger than these values*

***10 Remediate all sediment samples with a 3 (Med-high) or 4 (High) ERM-Q/PEL-Q Priority category and all of the Jefferson Canal Spoil Pile***

*a Using 1 st effects benchmarks in sediment, background levels in soils, and all dietary items linked to soil set to zero*

*b Using ½ 1 st effects benchmarks in sediment, background levels in soils, and all dietary items linked to soil set to zero*

*c Using detection limits sediment, background levels in soils, and all dietary items linked to soil set to zero*

***11 Remediate all sediment samples with a 3 (Med-high) or 4 (High) ERM-Q/PEL-Q Priority category and all of the Jefferson Canal Spoil Pile***

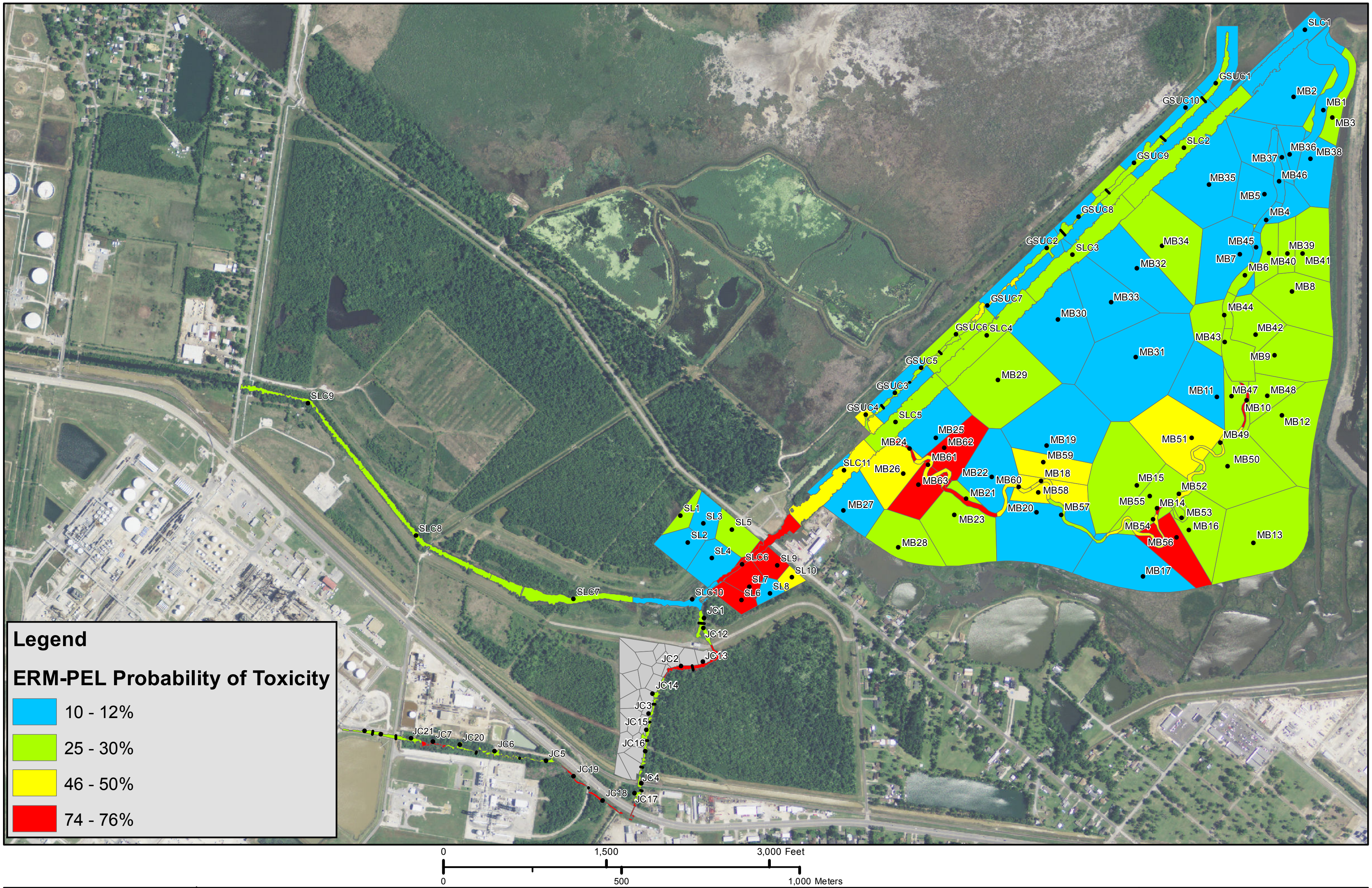
*a Using 1 st effects benchmarks in sediment, background levels in soils, and BAFs for all dietary items*

*b Using ½ 1 st effects benchmarks in sediment, background levels in soils, and BAFs for all dietary items*

*c Using detection limits sediment, background levels in soils, and BAFs for all dietary items*

Note:

Italics denotes a new scenario that was not presented at the August 31, 2011 meeting or the September 14, 2011 web conference.




# ERM & PEL Probabilities of Toxicity to Amphipods Sediment Samples

## Star Lake Canal Superfund Site Jefferson County, Texas

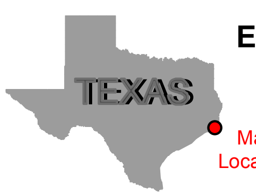





Image: 2009

Map Date
12 September 2011

Cardno ENTRIX
5252 Westchester, Suite 250
Houston, TX 77005
ph. (713) 666-6223
fx (713) 666-5227
www.cardnoentrix.com

Coordinate System:
NAD 1983 UTM Zone 15N

Date: 09/14/11 Rev. Date: xx/xx/xx PM: AGH GIS Analyst: AJB Map Document: ERM_PELProb_Thiessen_20110914_ajb.mxd Project Number: 1169901-6000-008 PDF Document: ERM_PELProb_Thiessen_20110914_ajb.pdf Plot Size: 8.5 x 11